

# **Biological Weapons: Limiting the Threat**

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# Chapter 1

## Introduction

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The transcendence of biological warfare (BW)—over medicine and public health, private criminal acts, terrorism, interstate warfare, and international law directed at the elimination of BW—makes this one of the most intricate topics of discourse, poses very difficult security problems, and opens some novel challenges in the ethical domain. (See Table 1.1.) That same transcendence confounds efforts to organize governmental and intergovernmental measures of control: health authorities will need to negotiate with the military, with law enforcement, and with environmental managers. And all will have to cope with how to enhance security without imposing intolerable stresses on personal liberties and on freedom of travel and of commerce.

Prior to the August 1997 BW theme issue from which this volume developed, the topic of BW had last been covered systematically by the *Journal of the American Medical Association (JAMA)* as part of a discourse on weapons of mass destruction in August 1989.<sup>1</sup> We recall that 1989 marked the bicentennials of the U.S. presidency and of the French Revolution. By year's end, perhaps not by pure coincidence, 1989 also marked

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1. Jane M. Orient, "Chemical and Biological Warfare: Should Defenses Be Researched and Deployed?" *Journal of the American Medical Association (JAMA)*, Vol. 262, No. 5 (August 4, 1989), pp. 644–648; Victor W. Sidel, "Weapons of Mass Destruction: The Greatest Threat to Public Health," *JAMA*, Vol. 262, No. 5 (August 4, 1989), pp. 680–682; and David L. Huxsoll, Cheryl D. Parrott, and William C. Patrick III, "Medicine in Defense against Biological Warfare," *JAMA*, Vol. 262, No. 5 (August 4, 1989), pp. 677–679.

Table 1.1. Germs as Arms: Basic Issues.

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BW (biological warfare) versus CW (chemical warfare): living germs versus chemicals; germs might self-amplify and spread; germs are biologically unstable and could mutate to higher virulence
Underlying science is unalterably dual-use: licit defensive exploration targeted against natural disease
Production is dual-use up to point of weaponization
Facilities moderate scale; few external signatures easily concealed or masked by licit programs
Weapons are potent, but unfamiliar and unreliable in military context
Tactical defense is easy: physical barriers (masks, suits)
Latent period up to 36 hours: disease may be treatable; hence need to focus on civil health preparedness
Hardly understood until now, these are "strategic" weapons. At the same time, they are accessible to small powers or groups and seen as answer to a superpower confident about the "revolution in military affairs"
Capabilities can scarcely be denied; remedial and intelligence focus on intentions needed

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the collapse of the Soviet empire, and with that the end of the Cold War. The Biological Weapons Convention (BWC) had been in place since 1972; nevertheless, compliance with that convention on the part of great states, notably Russia, was the centerpiece anxiety in 1989. U.S. national policy was likewise concentrated on the defense of troops in tactical combat settings.

Medical interests, notably symbolized by the World Health Organization's pleas, had played a significant role in the diplomatic priority given to the BWC, and then to concern for its enforcement.<sup>2</sup> Since 1989, the Persian Gulf War, the escalation of terrorism, and a recrudescence of many infections have added new dimensions to concerns for the malicious incitement of disease. Iraq was proven to have developed and militarized a repertoire of BW agents, notably anthrax spores.<sup>3</sup> Terrorists achieved new levels of violence in New York, Oklahoma City, and Tokyo and operated on ever more incomprehensible and unpredictable rationales. Having deployed chemical weapons in Tokyo and dabbled in BW, terrorists would soon be attempting to deploy BW on an increasing scale. It is not difficult to find recipes for home-brew botulinum toxin on the World Wide Web; terrorists justify this with the proposition that every citizen should have the parity of power with government. Meanwhile, the growth of biotechnology has great promise for new modes of diag-

nosis and therapy, but if left unchecked, advances in this field will allow for even more troublesome microbiological agents of destruction.

This volume touches on a set of timely concerns that unite national security and public health, concerns that cry out for the well-articulated convergence of the human community worldwide. Various chapters in this book discuss the historical,<sup>4</sup> diplomatic,<sup>5</sup> and legal<sup>6</sup> background; modalities of diagnosis and management;<sup>7</sup> and case studies of small-scale BW attacks that have already been perpetrated, though amateurish in design and ending with limited malefaction.<sup>8</sup>

While BW is widely regarded as the absolute perversion of medical science, the problems of invoking humanitarian regulation of means of warfare are well understood.<sup>9</sup> Resort to warfare is tied to the use of any means necessary for the survival of the state, including organized violence. It is mainly the peacetime behavior of states that can be regulated by international law, and this has evolved toward greater coherence and impact in an interdependent global economy. Even in the thrall of violent combat, states will also be deterred when there is a firm international resolve: Iraq did not, after all, use its massive stockpiles of anthrax in the Gulf War.<sup>10</sup>

The twentieth century has seen the exercise of massive violence on an immense scale, even without major resort to BW. What distinguishes BW is the understanding that its habitual practice would be ruinous to personal security and civil order, perhaps more grievously than any other weapon likely to get into the hands of disgruntled individuals or rogue states. One *sine qua non* for the elimination of BW is its utter delegitimation; in the language of the Geneva Protocol of 1925, it must remain "justly condemned by the general opinion of the civilized world."<sup>11</sup>

As a matter of international law, any debate has already been settled

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4. See the chapter by George W. Christopher et al. in this volume.

5. See the chapters by Robert P. Kadlec, Allan P. Zelicoff, and Ann M. Vrtis, and Richard Danzig and Pamela B. Berkowsky in this volume.

6. See the chapter by James R. Ferguson in this volume.

7. See the chapters by David R. Franz et al., and Harry C. Holloway et al. in this volume.

8. See the chapters by Thomas J. Török et al., and Shellie A. Kolavic et al. in this volume.

9. Hedley Bull, *The Control of the Arms Race* (New York: Praeger for the Institute for Strategic Studies, 1961); and Joshua Lederberg, "The Control of Chemical and Biological Weapons," *Stanford Journal of International Studies*, Vol. 7 (1972), pp. 22–44.

10. See the chapter by Raymond A. Zilinskas in this volume.

11. Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (Geneva Protocol), 1925.

2. World Health Organization (WHO), *Health Aspects of Chemical and Biological Weapons* (Geneva: WHO, 1970).

3. See the chapter by Raymond A. Zilinskas in this volume.

by the wide adoption of the 1972 BWC: the abnegation of biological weapons is approaching the status of a norm of international behavior, going beyond a mere contract for mutual compliance. When an international consensus can be achieved and sustained, as happened after Iraq's invasion of Kuwait, severe sanctions can be imposed by the international community. The task is to build that moral consensus and give it sustainability and priority over more transient aspects of perceived national interest, like commercial advantage or access to resources.<sup>12</sup> We are happily less burdened by the choosing of sides in the Cold War and the strange bedfellows engendered by that process. There is much to answer for in the nonchalance exhibited by most of the world when Iraq used chemical weapons in its wars against Iran and on its own Kurd dissidents.<sup>13</sup>

Writing fifty years ago, Vannevar Bush remarked, in puzzling why BW had not been deployed at the height of World War II: "Without a shadow of a doubt there is something in man's make-up that causes him to hesitate when at the point of bringing war to his enemy by poisoning him or his cattle and crops or spreading disease. Even Hitler drew back from this. Whether it is because of some old taboo ingrained into the fiber of the race. . . . The human race shrinks and draws back when the subject is broached. It always has, and it probably always will."<sup>14</sup> Bush could not offer these as reliable reassurances, and he surely played a large role in instituting and maintaining what became the U.S. offensive BW development program. This program started during World War II, and escalated in the Cold War competition with the Soviet Union until 1969, with President Nixon's unilateral abnegation. In due course this was followed by the successful negotiation of the BWC of 1972, and its coming into force internationally in 1975.

Scrupulous adherence to the BWC on the U.S. side, coming to the bar with clean hands, is of course an absolute prerequisite to the moral platform of BW prohibition. There is no more powerful instrument for that credibility than self-inspection. In free societies, that responsibility will largely devolve on well-informed scientific and medical professionals. That community also has deep-seated ties with peers even in some

authoritarian states, bonds that should be cultivated to develop common ground even against obstacles of parochial interest.

Unlike nuclear weapons, the capability for BW is unlikely to be reliably contained by any degree of legal prohibition and formal verification. The facilities required for producing and dispensing BW agents are modest, easily concealable, and almost indistinguishable from licit production of pharmaceuticals and vaccines. The same holds for the underlying technical knowledge, which is part and parcel of medical research and education. The potential for grave enhancement of virulence and the intractability of pathogens for BW use go hand in hand with the advances of biotechnology for human life enhancement.<sup>15</sup> Verification still plays a role as part of a lawful process of investigation and indictment of malefactors. But the key to consolidation of the law on BW is its rigorous enforcement, and this will require a consensus even among U.S. friends and allies that has yet to be achieved—partly out of the expectation that the United States will always bear the onus as enforcer of last resort. Moral conviction and discreet technical education about the implications of leaving BW unchecked then go hand in hand.

As for the smaller and more marginal states, the United States should anticipate some ambivalence about forgoing weapons that might mitigate the overwhelming military power of a super-state. To enlist their unre-served cooperation in denying the use of BW, the United States should be far more proactive in mobilizing its health technology to stamp out rampant infectious disease globally.<sup>16</sup> Tuberculosis remains the earth's prime killer, and malaria, with hundreds of millions of infected people, the greatest drain on human vitality. It is scandalous that these coexist with a technology that will soon have plotted the entire human genome. Lacking robust technical solutions to the malevolent use of BW, the United States has little to call upon besides this common moral ground to prevent attack.

If despite deterrence, law, and moral suasion, the means of attack cannot be forsworn, the obligation remains to be prepared to blunt them. Physicians and local health services, along with police and firefighter first-responders, are in the front lines to deal with health emergencies. This same apparatus is needed to deal with natural disease outbreaks: recall *Legionella*, Influenza A-H5N1, and *Escherichia coli* O157:H7 of recent

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12. Leonard A. Cole, *The Eleventh Plague: The Politics of Biological and Chemical Warfare* (New York: W.H. Freeman, 1996).

13. H. Kadivar and S.C. Adams, "Treatment of Chemical and Biological Warfare Injuries: Insights Derived from the 1984 Iraqi Attack on Majnoon Island," *Military Medicine*, Vol. 156 (1991), pp. 171-177.

14. Vannevar Bush, *Modern Arms and Free Men* (New York: Simon and Schuster, 1949), pp. 142, 146.

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15. A.P. Pomerantsev, N.A. Staritsin, Y.V. Mockov, and L.I. Marinin, "Expression of Cereolysin Ab Genes in *Bacillus Anthracis* Vaccine Strain Ensures Protection against Experimental Hemolytic Anthrax Infection," *Vaccine*, Vol. 15 (1997), pp. 1846-1850.

16. Joshua Lederberg, "Infection Emergent," *JAMA*, Vol. 275, No. 3 (January 17, 1996), pp. 243-245.

vintage. The local responders also need to be trained in exercises entailing support from the Public Health Service and, if need be, military personnel. While BW attacks may be widely dispersed, they are amenable to medical intervention far more than trauma from explosives or chemicals, provided diagnosis is timely and resources can be mobilized. In many cases, there may be little or no advance warning. Vigilance in understanding the fate of victims near the dose-epicenter might provide an alert for the much larger cohorts likely to receive smaller doses and exhibit longer incubation times—a window of opportunity for treatment.

Several chapters in this volume point to recent progress, and a long way still to go, in the coordination of resources among a host of U.S. governmental agencies: federal, state, and local.<sup>17</sup> Recent press reports also speak to a rising tide of attention by responsible officials.<sup>18</sup> In view of the rapid dispersal of people via jet aircraft and the globalization of commerce, including foodstuffs, that coordination needs to be extended to a global venue. This scarcely exists at all at the present time, although the WHO has energetic programs to deal with influenza and HIV, and could be the nucleus of more extensive disease surveillance. With the growing recognition that BW is a strategic weapon, directed most effectively at large urban populations, cooperative public health measures might well reach the agenda of U.S. security alliances like NATO. Military force protection against BW and chemical warfare (CW) is fairly advanced; with the dissemination of vaccines, antidotes, and masks, these weapons are not likely to confer great tactical advantage to the perpetrator. Civil populations, near actual and potential theaters of combat or clandestine attack—and that no longer excludes the U.S. homeland—deserve comparable protection, if only to reduce the temptations for the aggressors and soften the dilemmas and collateral harm of retaliation.

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17. See the chapters by Holloway et al. and Jonathan B. Tucker in this volume.

18. Judith Miller and William J. Broad, "Clinton Expected to Back Plan to Deter Terrorist Attack," *New York Times*, April 26, 1998, p. 1.

## Chapter 18

### Epilogue

Joshua Lederberg

As the chapters in this volume were being assembled, our policy perspectives were informed by new happenings, and by governmental actions and reactions. Saddam Hussein renewed his harassment of the UNSCOM inspectors seeking closure on Iraq's programs in biological weapons (BW) and other weapons of mass destruction. In December 1998, Iraq's obstruction of UNSCOM inspections led the United States and the United Kingdom to launch aerial attacks on Iraq. That escalation might be a deterrent and warning, or it might provoke unreasoned responses, including the use of BW if the regime inferred it had nothing more to lose. The dilemma persists on how to invoke punishment of deviant autocrats without injuring captive populations even more severely; so does the question of looking beyond violence to the causes of belligerency. At one level, we know the danger that violence will beget violence. At another, the history of nations has shown how the most violent exemplars, like Nazi Germany and Imperial Japan, could—at terrible cost to themselves and others—be pacified and become models of geopolitical restraint and economic success. Democracies which regard themselves as humane will be torn and sometimes self-deterred by such considerations, probably more than by threats of forceful retaliation. Saddam may not know this well enough to refrain from launching terrorist reactions; there is also always the cloak of fringe zealots acting on their own initiative.

This is the story line for the vicious bomb attacks on U. S. embassies in Kenya and Tanzania on August 8, 1998, which were attributed to Osama bin Laden. Bernard Lewis has retrieved bin Laden's formal declaration of war against the United States and its citizens from the Arabic press.<sup>1</sup> The aim is the expulsion of U.S. interests from the holy Arabian

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1. Bernard Lewis, "License to Kill: Usama Bin Ladin's Declaration of Jihad," *Foreign Affairs*, Vol. 77, No. 6 (November/December 1998), pp. 14–19.

Peninsula. In the process, however, hundreds of native Africans have been injured or killed. This may go even beyond casual disregard of uninjured bystanders—it conveys the message that diplomatic relations of any country with the United States entail a lethal liability.

This atmosphere has not triggered acute defensive precautionary mobilization beyond routine travel advisories. However, past months have witnessed a growing concern expressed in public pronouncements and official actions. U.S. Secretary of Defense William Cohen's foreword in this volume is reflected in President Clinton's Annapolis speech on May 22, 1998, which presents:

"three new initiatives—the first broadly directed at combatting terrorism; the other two addressing two potential threats from terrorists and hostile nations, attacks on our computer networks and other critical systems upon which our society depends, and attacks using biological weapons. . . . We will work to upgrade our public health systems for detection and warning, to aid our preparedness against terrorism, and to help us cope with infectious diseases that arise in nature. We will train and equip local authorities throughout the nation to deal with an emergency involving weapons of mass destruction, creating stockpiles of medicines and vaccines to protect our civilian population against the kind of biological agents our adversaries are most likely to obtain or develop. And we will pursue research and development to create the next generation of vaccines, medicines and diagnostic tools. The Human Genome Project will be very, very important in this regard. And again, it will aid us also in fighting infectious diseases. . . . To make these three initiatives work we must have the concerted efforts of a whole range of federal agencies—from the Armed Forces to law enforcement to intelligence to public health. I am appointing a National Coordinator for Security, Infrastructure Protection, and Counterterrorism, to bring the full force of all our resources to bear swiftly and effectively."<sup>2</sup>

These decisions are reflected in Presidential Decision Directive 62 (PDD-62), and in the appointment of Richard Clarke of the National Security Council as the National Coordinator. Inter-agency discussions with regard to allocations of responsibility and budget are continuing. Significant announcements include the assignment of backup responsibilities to the National Guard.<sup>3</sup> The U.S. Atlantic Command (ACOM) already bears operational responsibility for "Homeland Defense," a theme much discussed in recent months, and it may be given further tasks in this arena. Not least of these is planning for the security of our ports of embarkation, the logistic chokepoints for maritime buildup and supply

of any U.S. force projection overseas. The Department of Justice will take over the training of local emergency responders to function safely and effectively in contaminated environments. Acting on its own, and impelled by past experiences like the attack on the World Trade Center in 1993, New York City has already mounted an extensive program that will be a model for other cities.<sup>4</sup> In addition, the FBI will establish a National Domestic Preparedness Office—a canonical shopping window for enquiries and appeals from local officials who are otherwise perplexed about where to turn for assistance from the complex federal establishment. These proposals go a long way toward meeting the criteria set out in a thoughtful paper by three recent members of the Clinton administration, Ashton Carter, John Deutch, and Philip Zelikow.<sup>5</sup> They remark, however, that "one should not place faith in czars. Real power still resides in the executive departments that have people, equipment, money, and the capacity to get things done."<sup>6</sup> These requirements have been elaborated in further detail by Richard Falkenrath and his colleagues.<sup>7</sup>

Efforts to engage Congress have been partly successful, but predictably face some resistance as "budget-busting" when incremental funding is sought. While there is substantial verbal endorsement of the priority that should be assigned to domestic bio-defense as an element of national security, it still fares poorly in competition with the long-established traditional military concerns, the end of the Cold War notwithstanding.

The R&D requirements for bio-defense are barely touched upon in the current volume. They range from the most far-reaching innovations that will be called upon to deal with exotic viral infections to banal items like inexpensive, citizen-adapted protective masks. Protocols for the management of infectious disease were neither designed nor validated for mass casualty settings, where, for example, available antibiotics are in short supply and rational schemes for extending those supplies will be desperately needed. Nor have our FDA and other regulatory and ethical regimes been confronted with emergent crises where thousands or millions of lives may be at stake, awaiting resolution of bureaucratic contradictions. Some of these matters have been given initial study by the

2. Speech by President William Clinton, Annapolis, Maryland, May 22, 1998; text at [www.whitehouse.gov](http://www.whitehouse.gov). See also the foreword by William S. Cohen in this volume.

3. See the foreword by William S. Cohen in this volume.

4. Judith Miller and William J. Broad, "New York Girding for Grim Fear: Deadly Germ Attack by Terrorists," *New York Times*, June 19, 1998.

5. Ashton Carter, John Deutch, and Philip Zelikow, "Catastrophic Terrorism: Tackling the New Danger," *Foreign Affairs*, Vol. 77, No. 6 (November/December 1998), pp. 80–94.

6. *Ibid.*

7. Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, *America's Achilles' Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, BCSIA Studies in International Security (Cambridge, Mass.: The MIT Press, 1998).

Institute of Medicine.<sup>8</sup> However, the delegation of responsibility to public authorities, and if so which ones, should be deliberated during times of peace, and informed consent conferred or denied; this cannot be achieved in the midst of crisis.

Among the triumphs of medical science and international cooperation in this century has been the global eradication of smallpox. Once among the major killers of humankind, smallpox has been eliminated from circulation by concerted programs of vaccination. The last authenticated case of naturally spread disease occurred in 1977, and the WHO officially declared eradication in 1979. Since then, abandonment of routine vaccination has been the accepted doctrine and general practice: the scourge had been lifted, and no further precautions were needed. Consequently we now have, globally, a whole generation of humans with no history of exposure either to smallpox virus or to the protective vaccine. This is unprecedented in human experience, though it may be likened to the condition of Western Hemisphere natives prior to the European exploration and conquest. With recent rumor and Russian defectors' reports of unabated experimentation with smallpox as a weapon in defiance of the BW treaty, anxieties about resulting U.S. vulnerability have been heightened.<sup>9</sup> Outbreaks have happened before, and they could probably be contained—but only if vaccine stocks, now all but depleted, are refreshed and pre-positioned.<sup>10</sup> This would not be very expensive; anti-viral medication would be equally valuable and an important complement if that could be materialized with renewed R&D.

My personal concern about the blight of biological weaponry, and the subversion of medical technology to the intentional spread of plagues, goes back many years. In 1970, I had occasion to address the United Nations Committee on Disarmament in Geneva, which focused on arms control as an important remedial device. The Biological Weapons Convention has been in force since 1975; it is now deeply embedded in the law of nations. The issue now is its enforcement, which depends on the institutionalized acknowledgment of and respect for that law. BW is a special weapon, with implications for civility of life that set it apart from many other kinds of violence. Most of the other arguments remain hardly

altered, except for the burgeoning realization of what biotechnology could bring us, for good or for evil.

### *From the Author's Statement to the Conference of the UN Committee on Disarmament*

Recent advances in molecular biology have important implications for human welfare. On the one hand, they help man to a deeper understanding of his own evolution and functioning as the most complex of life forms on earth. They support revolutionary advances in medicine in such fields as cancer, aging, congenital disease and virus infections. They will also play a vital role in agriculture and related industries.

On the other hand, molecular biology might be exploited for military purposes and result in a biological weapons race whose aim could well become the most efficient means for removing man from the planet. For example, Professor Gobind Khorana of the University of Wisconsin recently reported the synthetic assembly of a small gene through chemical operations on DNA components. It will be a major step to extend this technical capability to the synthesis of small viruses. But this surely could be accomplished within the next decade. This procedure will allow an unlimited range of experimental variations of the genetic structure of different viruses, a process that has many important potential applications for human health. It also offers us the prospect of engineering the design of viruses to exquisite detail, for vaccines or for weapons. Accomplishments like Khorana's have been possible in a small laboratory on an annual research budget that is minuscule compared to weapons hardware. A serious military investment in this area could be expected to outstrip this already breathtaking pace of advance by manyfold.

### THREAT TO MAN

For many years biological warfare has been given only incidental attention as a subject of diplomatic discussion, for it seemed to have little bearing on the adjustments of power that were the main work of specialists in foreign affairs.

We now begin to realize that the intentional release of an infectious particle, be it a virus or bacterium, from the confines of the laboratory or of medical practice must be formally condemned as an irresponsible threat against the whole human community.

A large epidemic, involving millions of people spread over time and space, is an immensely complicated phenomenon about which it is very difficult to make accurate scientific predictions. This combination of very

8. Institute of Medicine, "Improving Civilian Medical Responses to Chemical or Biological Terrorist Incidents," National Research Council, Washington, D.C., 1999.

9. Richard Preston, "The Bioweaponers," *New Yorker*, March 9, 1998, pp. 52–65.

10. Joel G. Breman and D.A. Henderson, "Poxvirus Dilemmas—Monkeypox, Smallpox, and Biologic Terrorism," *New England Journal of Medicine*, Vol. 339 (1998), pp. 556–559.



grave potential hazard with a high degree of unpredictability is a peculiar attribute of biological weaponry at its present stage of development. This has a great deal to do with the rational doctrine that so far has placed a relatively low value on its military utility.

#### IT COULD BE TOO LATE

The present situation thus might provide the most favorable opportunity for international action to regulate the further development and proliferation of biological warfare. I am convinced we know enough about it to have legitimate concern about its future prospects. Until now no nation appears to have staked its security to any significant degree on BW armaments. I would therefore hope this provides a basis for accord. If we wait until BW has been developed into a reliable armament for use under a range of military doctrine, we must all fear that it could then be too late to disengage important powers from their commitment to it.

The barriers that now give advanced countries a measure of protection against plague could be breached by further technical developments if a substantial effort were to be applied during the next decade to making the plague bacillus into a weapon.

Other infectious agents might be even more adaptable. Some of man's deadliest enemies are viruses which, like yellow fever, are transmitted by mosquitos or other arthropods. These have the advantage, from a military standpoint, that they should not start a potentially retroactive epidemic in areas where the vector insect does not normally abound. It is already evident that such insect-borne viruses could be applied in the first instance by direct aerial dissemination, with little or no further spread from the first wave of infected targets.

Recent reports of airborne or pneumonic rabies, a terrible disease, which is normally spread by the bite of an infected dog or animal, illustrate this possibility. There is then the danger that, if a large nucleus of people is attacked in this way, further evolution of the virus will occur to give rise to a new form of the disease that does spread from person to person, contrary to the calculations of the attacker. The Black Death itself underwent a similar evolution from the original bubonic flea-borne plague to outbreaks of the far more contagious pneumonic variety.

We have learned in recent years that viruses undergo constant evolution in their own natural history, not only by mutations within a given strain, but also by the natural cross-hybridization of viruses that superficially appear to be only remotely related to one another. Furthermore, many of us already carry viruses in our body cells of which we are unaware for years, and which may be harmless—though they may eventually cause the formation of a tumor, or of brain degeneration or other

diseases. At least in the laboratory, we can still cross-breed them with other viruses to give rise to many new forms.

My gravest concern is that similar scientific breakthroughs of a rather predictable kind will be made and their potential military significance exploited, so as to result in a transformation of current doctrine about "unreliable" biological weapons. We are all familiar with the process of mutual escalation in which the defensive efforts of one side inevitably contribute to further technical developments on the other and vice versa. The mere existence of such a contest produces a mutual stimulation of effort; moreover, there is no practical system of counterintelligence that will protect secret work for an indefinite period of time from becoming known to others. And the potential undoubtedly exists for the design and development of infective agents against which no credible defense is possible, through the genetic and chemical manipulation of these agents.

#### SUBVERSION OF SCIENCE

Permit me, now, to ask a rhetorical question: Can we establish a world order that will, in effect, protect "you," as representative of the global community, from the subversion of the scientific advances to which my own peers and myself have dedicated their careers?

I wish I could be sure that such a remark would always be received with an understanding of the ironic spirit with which it is uttered. I do not have to tell you of the worldwide attack on science, the flight from reason that has tempted so many young people and makes so many dilemmas for those of us in university life.

What the youth see as the perversion of knowledge is, I believe, an important aspect of their repudiation of us. Among the undergraduates at my own university, there is no prospect more disheartening than the idea that even health research is subject to exploitation in the most inhumane direction imaginable.

For many years I have advocated that the control of biological warfare be given a special place in international and national initiatives for reasons I have mentioned. I am deeply gratified that President Nixon's announcement last November 25, which disavowed offensive biological warfare development, has made it possible for me to address these issues in terms fully consistent with the policy of the government of my own country.

Even after agreement to eliminate biological weapons, we will still remain very vulnerable to a form of biological warfare that is beyond the reach of any covenant that we can make. This is the warfare practiced upon us by nature, the unremitting barrage of infection by old and by

new agents that still constitute a very large part of the perils to normal and healthy life.

#### VEXING VIRUS INFECTIONS

We have all had vexing, perhaps even tragic, personal experiences with virus infections. You will all recall the global epidemic of influenza that was first identified in Hong Kong about three years ago. This was not a particularly severe form of the virus and its eventual mortality was probably only in the tens of thousands. It is wrong, however, to believe that there is any assurance that the next epidemic of this kind will be as mild; and we have still developed only the most feeble and precarious protection against this threat whose impact is shared by all the nations, but against which very little common defense has been erected.

You will also recall having read from time to time about small outbreaks of mysterious new diseases like "Lassa fever" and the "Marburg virus." These were both extremely dangerous threats; and while much credit must be given to the diligence of the medical people who dealt with the outbreaks, a large element of pure luck was involved in localizing these incidents. We must expect that there are many additional viruses already indigenous to primate and human populations in primitive areas and to which the inhabitants of advanced countries are extremely vulnerable.

Yellow fever is a historically important disease that now belongs in the same category. It is now maintained on earth mainly through an animal reservoir of infection, in the monkeys in tropical jungles. Urban populations are now protected from yellow fever by campaigns to abolish the fever-carrying species of mosquitos in South America and by the availability of excellent vaccines in advanced countries. Mosquito species capable of transmitting yellow fever are, however, abundant in South Asia and the accidental introduction of yellow fever, for example, into India would be a human tragedy of catastrophic dimensions. Specialists in epidemiology are quite puzzled that this accident has not already happened and we have no good explanation for this good fortune.

My purpose is not to suggest the vulnerability of the Asian continent to biological military attack but rather to point out immense gaps in the pattern of international cooperative defenses that should be mounted but which have a relatively feeble standing in the present day world.

#### THREAT TO CROPS

Countries that are undergoing a transition in the development of their agriculture are vulnerable to analogous threats in biological warfare directed against crops as distinguished from human targets. These crops are

now newly vulnerable to destruction by plant pests of either natural or artificial origin. An outbreak of "coffee rust" is at this moment a serious threat to the agriculture and economy of Brazil; hoof-and-mouth disease made a costly incursion into British cattle a few years ago.

The promulgation of an international agreement to control biological warfare in a negative sense should, therefore, be accompanied by steps urgently needed to build positive efforts at international cooperation, a kind of defensive biological research against natural enemies of the human species.

One of the best assurances that any country might have that the microbiological research of its neighbors was directed toward human purposes would be constantly expanding participation in international health programs. Any country that publicly and avowedly subscribed to the total renunciation of secret BW research might conceivably be able to continue clandestine efforts without revealing their substantial content. It would, however, have great difficulty in maintaining such an effort, at any substantial level or quality of operation, while still keeping its very existence secret. Therefore, besides the obvious direct health benefits of expanded international cooperation we would also be rewarded by a higher level of mutual assurance that every party was indeed living up to the spirit of its obligations under a BW convention.

In conclusion, let me say that some of the speculations I have mentioned are ones that all of us must fervently hope will never materialize. But it would seem to me both foolish and arrogant to assume that our goodwill alone, without concrete arrangements, will serve to forestall the further development, proliferation and possible eventual recourse to what surely is one of the most ghastly methods of warfare imaginable.<sup>11</sup>

11. Joshua Lederberg, "Address to Conference of the Committee on Disarmament, August 5, 1970," Congressional Record, September 11, 1970, pp. E-8123-8124.